



# ROBOTITO

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## BUILD GUIDE

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## INTRO

The purpose of this rebuild was to redesign the Robotito to make its build more equivalent and compatible with the versions of robots used for the Introduction to Mobile Robots Class. This entailed redesigning the wheels, frame, battery carriage, component interfaces, and software for each component. The top of the frame (Sensor holder) was used on the build, although a new revision was made to fit the VL53L0X Time of Flight infrared distance sensors.

All 3D printed parts were modeled in Blender and reside in the V3>Parts folder in the robotito repository. The schematics were created using a prototyping program called Fritzing.

The code written was to make simple interfaces between the Raspberry Pi 3 to the VL53L0X infrared sensors, the motor driver, hall sensor encoders, and the Pi Camera V2.

There are test programs for the sensors, motors, and for the Pi Camera V2.

The Robotito was connected via SSH into the Raspberry Pi. The Pi also has VNC on it for connecting through the schools network.

## FILES

All project files reside in the V3 folder within the robotito-master repository

>V3

- > Code: Contains, you guessed it, the source code.
- > Various python libraries...3 folders with libraries for sensors, Motor\_HAT, VL53L0X sensors and SSD1306 LCD(No longer used on the robotito) and 4 test libraries(PIGPIO, gpiotest\_master, python-spi, wiring pi(These were used for testing various IO Pins for troubleshooting problematic components)
- > robotito:
  - >drawMap.py: Unfinished script used to draw a map from sensor information.
  - >Encoder.py: Class Encoders
  - >Functions.py: Holds the functions for robotito
  - >MotorDriver.py: Class Motordriver
  - >Sensors.py: Class Sensors
  - >robotito.py: A test script that allows a user to control robotito through the command line
- >Datasheets: Contains all datasheets for the components used.
- >Parts: Contains blender files, as well as corresponding .stl format files for 3D printing.  
Parts were printed by the Advanced Visualization Center, under the RoboBulls account
- >Pictures: Contains pictures of the build process.
- >Schematics: Contains the wiring diagrams in .jpg format, and the Fritzing files to analyze or augment them.
- >rosRoboitoPackage: Contains the beginning of the Robotito Package.
- >PartsToOrder.xlsx: Contains the sources for the parts ordered.

## PARTS TO ORDER

Part	URL	Price	Shipping	Qty	Total
Motor Drivers	<a href="https://www.amazon.com/Adafruit-Stepper-Motor-HAT-Raspberry/dp/B00TIY5JM8/ref=pd_sbs_23_2?encoding=UTF8&amp;pd_rd_i=B00TIY5JM8&amp;pd_rd_r=FF1ZYN6D3RBXF8HC41QJ&amp;pd_rd_w=ebGFA&amp;pd_rd_wg=4umRI&amp;psc=1&amp;refRID=FF1ZYN6D3RBXF8HC41QJ">https://www.amazon.com/Adafruit-Stepper-Motor-HAT-Raspberry/dp/B00TIY5JM8/ref=pd_sbs_23_2?encoding=UTF8&amp;pd_rd_i=B00TIY5JM8&amp;pd_rd_r=FF1ZYN6D3RBXF8HC41QJ&amp;pd_rd_w=ebGFA&amp;pd_rd_wg=4umRI&amp;psc=1&amp;refRID=FF1ZYN6D3RBXF8HC41QJ</a>	\$25.98		1	\$25.98
500 RPM motor	<a href="https://www.amazon.com/uxcell-39RPM-Reduction-Gearbox-Engine/dp/B071L9WPD8/ref=sr_1_5?s=hi&amp;ie=UTF8&amp;qid=1528135343&amp;sr=1-5&amp;keywords=6V%2Bmotor%2Bwith%2Bencoder&amp;th=1">https://www.amazon.com/uxcell-39RPM-Reduction-Gearbox-Engine/dp/B071L9WPD8/ref=sr_1_5?s=hi&amp;ie=UTF8&amp;qid=1528135343&amp;sr=1-5&amp;keywords=6V%2Bmotor%2Bwith%2Bencoder&amp;th=1</a>	\$15.09		4	\$15.09
Drums	<a href="https://www.amazon.com/Pololu-Universal-Aluminum-Mounting-2-56/dp/B01CTUP4IG/ref=sr_1_1?s=toys-and-games&amp;ie=UTF8&amp;qid=1522088023&amp;sr=1-1&amp;keywords=Pololu+Universal+Aluminum+Mounting+Hub+for+3mm+Sha">https://www.amazon.com/Pololu-Universal-Aluminum-Mounting-2-56/dp/B01CTUP4IG/ref=sr_1_1?s=toys-and-games&amp;ie=UTF8&amp;qid=1522088023&amp;sr=1-1&amp;keywords=Pololu+Universal+Aluminum+Mounting+Hub+for+3mm+Sha</a>	\$5.99	\$4.89	2	\$9.88
Brackets	<a href="https://www.amazon.com/Pololu-BRACKET-MICRO-10x12x26mm-MOTORS/dp/B00B887HE0/ref=sr_1_1_mrg_2?s=industrial&amp;ie=UTF8&amp;qid=1522088092&amp;sr=1-2_mrg_0&amp;keywords=Pololu+Micro+Metal+Gearmotor+Bracket+Extended+Pair">https://www.amazon.com/Pololu-BRACKET-MICRO-10x12x26mm-MOTORS/dp/B00B887HE0/ref=sr_1_1_mrg_2?s=industrial&amp;ie=UTF8&amp;qid=1522088092&amp;sr=1-2_mrg_0&amp;keywords=Pololu+Micro+Metal+Gearmotor+Bracket+Extended+Pair</a>	\$4.99	\$3.89	2	\$8.88
Adafruit VL53LOX	<a href="https://www.amazon.com/Adafruit-Industries-VL53L0X-DISTANCE-Evaluation/dp/B06XPVJCZJ/ref=sr_1_3?ie=UTF8&amp;qid=1528135249&amp;sr=8-3&amp;keywords=ToF+sensor">https://www.amazon.com/Adafruit-Industries-VL53L0X-DISTANCE-Evaluation/dp/B06XPVJCZJ/ref=sr_1_3?ie=UTF8&amp;qid=1528135249&amp;sr=8-3&amp;keywords=ToF+sensor</a>	\$15.95		4	\$63.80
Raspberry Pi 3	<a href="https://www.amazon.com/Raspberry-Pi-RASPERRYPI3-MODB-1GB-Model-Motherboard/dp/B01CD5VC92/ref=sr_1_3?s=electronics&amp;ie=UTF8&amp;qid=1525362540&amp;sr=1-3&amp;keywords=Raspberry+pi+3">https://www.amazon.com/Raspberry-Pi-RASPERRYPI3-MODB-1GB-Model-Motherboard/dp/B01CD5VC92/ref=sr_1_3?s=electronics&amp;ie=UTF8&amp;qid=1525362540&amp;sr=1-3&amp;keywords=Raspberry+pi+3</a>	\$36.99		1	\$184.95
Pi Camera V2	<a href="https://www.amazon.com/LANDZO-Mini-Camera-Module-Raspberry/dp/B074K2ZPCN/ref=sr_1_2_sspa?ie=UTF8&amp;qid=1522089424&amp;sr=8-2-spons&amp;keywords=pi+camera+v2&amp;psc=1">https://www.amazon.com/LANDZO-Mini-Camera-Module-Raspberry/dp/B074K2ZPCN/ref=sr_1_2_sspa?ie=UTF8&amp;qid=1522089424&amp;sr=8-2-spons&amp;keywords=pi+camera+v2&amp;psc=1</a>	\$24.99		1	\$24.99
AdaFruit Powerboost 1000	<a href="https://www.amazon.com/Adafruit-2030-PowerBoost-1000-Basic/dp/B00R3QWEAS/ref=sr_1_1_sspa?ie=UTF8&amp;qid=1538373788&amp;sr=8-1-spons&amp;keywords=adafruit+powerboost&amp;psc=1">https://www.amazon.com/Adafruit-2030-PowerBoost-1000-Basic/dp/B00R3QWEAS/ref=sr_1_1_sspa?ie=UTF8&amp;qid=1538373788&amp;sr=8-1-spons&amp;keywords=adafruit+powerboost&amp;psc=1</a>	\$14.95		1	\$14.95

## **INSTALLING OS AND DEPENDENCIES**

The Raspberry Pi is running Raspbian 4.14.52 which can be downloaded here.

- Download Raspbian Linux (Stretch)

download here <https://www.raspberrypi.org/downloads/raspbian/>

(Download via torrent, if you value your time)

The .iso will need to go on a SD card of at least 8GB.

- To login remotely, enable SSH before you boot. Create a file called ssh(NO FILE FORMAT!) in the boot partition (the only partition that's normally visible to Windows and Mac computers). The ssh file does not have to contain anything, its presence tells Raspbian you want SSH enabled and the file will be deleted after that is done.

User name: pi

Password: raspberry

(Change password ASAP)

- Update

sudo apt-get update

- Get python-dev

sudo apt-get install python-dev python-pip build-essential python-smbus git

pip install upgrade distribute

pip install upgrade rpi.gpio

- Install Adafruit Motor-HAT-Python Library

<https://github.com/adafruit/Adafruit-Motor-HAT-Python-Library>

sudo apt-get update

cd ~/

-Install Adafruit VL53L0X Library

git clone [https://github.com/naisy/VL53L0X\\_rasp\\_python.git](https://github.com/naisy/VL53L0X_rasp_python.git)

cd VL53L0X\_rasp\_python

make

sudo python setup.py install

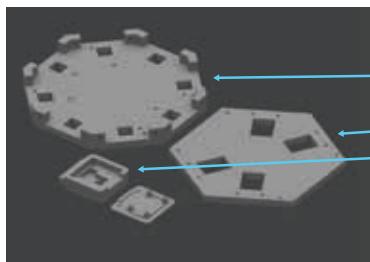
- Turn on camera, spi and i2c

## TOOLS AND PARTS LIST



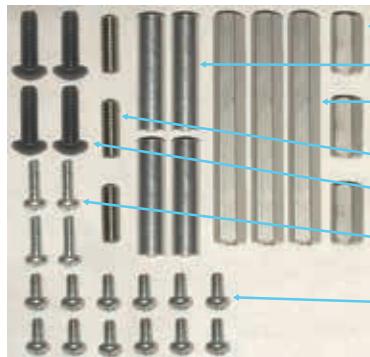
### TOOLS

- Soldering Iron
- Phillips head screwdriver
- Wire Strippers/cutters
- Dupont connector crimper
- 3mm Allen key
- 7/64in Allen key
- 5/32in Allen key



### 3D Printed Parts

- SensorHolder.stl	x	1
- Chassis.stl	x	1
- CameraFront.stl	x	1
- CameraBack.stl	x	1



### HARDWARE AND WIRES

#### SPACERS

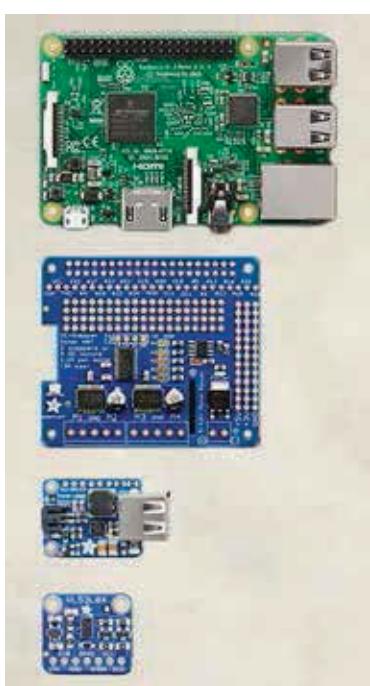
- 1/2in	x	3
- 1in	x	4
- 2in	x	3

#### SCREWS

- 1/2in x 5/32in set	x	3
- 1/2in x 3/32in hex	x	3
- 1/2in x 7/64in	x	4
- 1/4in x 7/64in	x	12

#### WIRING

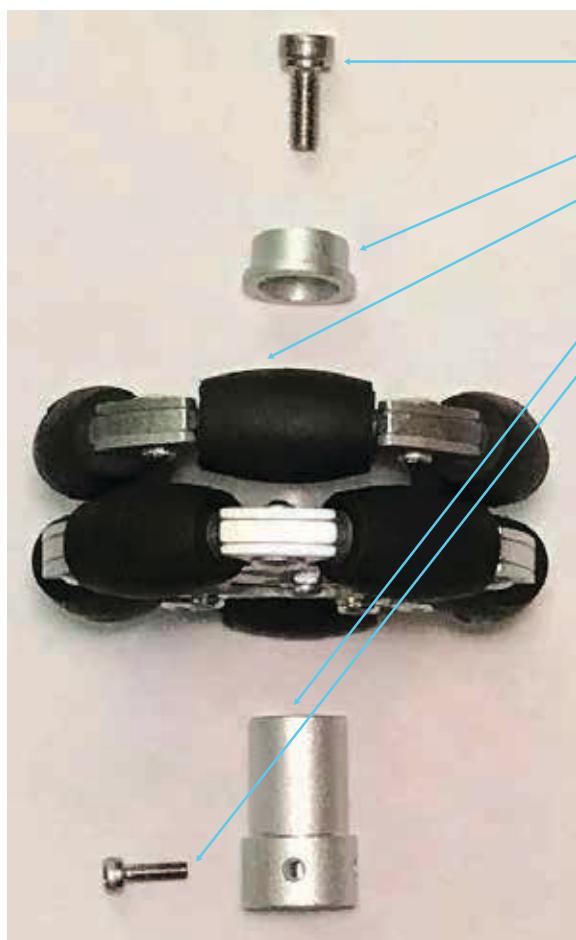
- F/F Dupont Wire 7in	x	22
- Fem Dupont Connectors	x	26
- Micro USB to USB 6in	x	1
- 20 Gauge Wire		
- Shrink Tubing		



### Components

- Raspberry Pi 3	x	1
- Camera V2	x	1
- MotorHat	x	1
- Powerboost 1000	x	1
- 6V Motors	x	4
- Motor Brackets (2 screws and nuts inc)	x	4
- Omni Wheel Assem. (Hubs and screws inc)	x	4
- VL53L0X	x	4
- Battery Holder (2 1/4in flathead screws included)	x	1

## WHEELS AND MOTORS

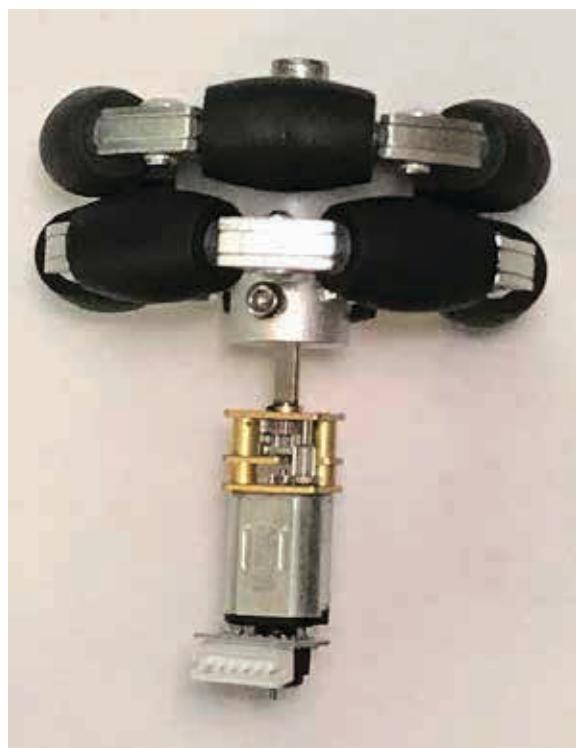


PARTS	
x	4
x	4
x	4
x	4
x	4
x	4
x	4

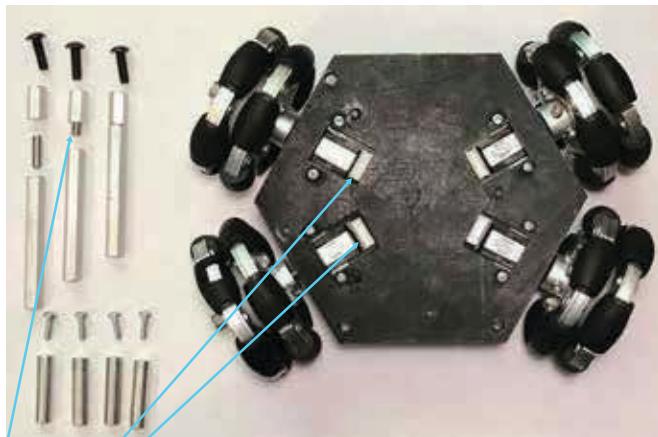


### ASSEMBLY

- Screw in the Hub screw through the Front hub, through the Omni Wheel and into the Back Hub. - Tighten
- Insert Motor axle into Back Hub and tighten Axle Screw
- Place Motor Bracket on Motor Oriented like this
- Repeat for all wheels



## MOTORS AND CHASSIS

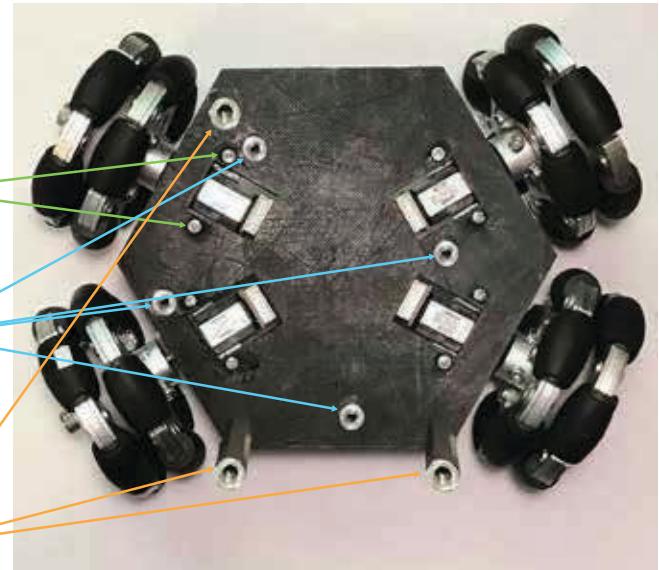


### PARTS

- Motor Assemblies	x	4
- Chassis	x	1
- Bracket scr	x	4
- Bracket nuts	x	4
- 1/2in spacer	x	3
- 2in spacer	x	3
- 1in spacer	x	4
- 1/2in x 3/32in hex	x	3
- 1/2in x 5/32in scr	x	3
- 1/2in x 7/64in scr	x	4

### ASSEMBLY

- Make sure the motors are oriented correctly with the encoders' connectors facing upwards through the chassis. The Bracket/Motor Assemblies are on the bottom of the chassis
- Fasten those Assemblies from the top(opposite side from Motors) of the chassis using the Bracket Screws and Nuts(included with the Motor Brackets)
- Fasten the 1in spacers to the top of the chassis with 1/2in x 7/64in screws.
- Screw in each 1/2in set screw into one 1/2in spacer with the keyed side going through the 1/2in spacer
- Screw that assembly into a 2in spacer
- Fasten those assemblies facing upwards on to the chassis with 1/2in hex screws

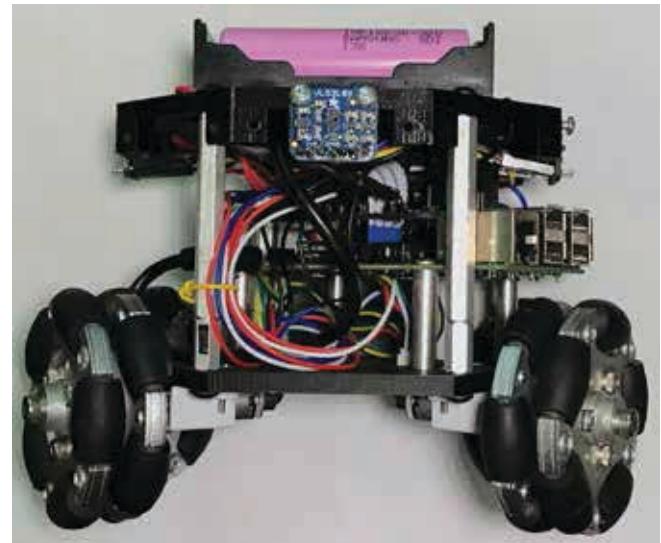
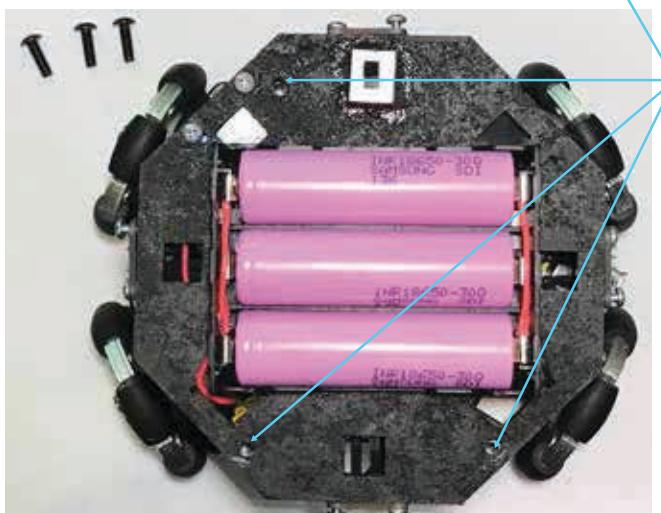
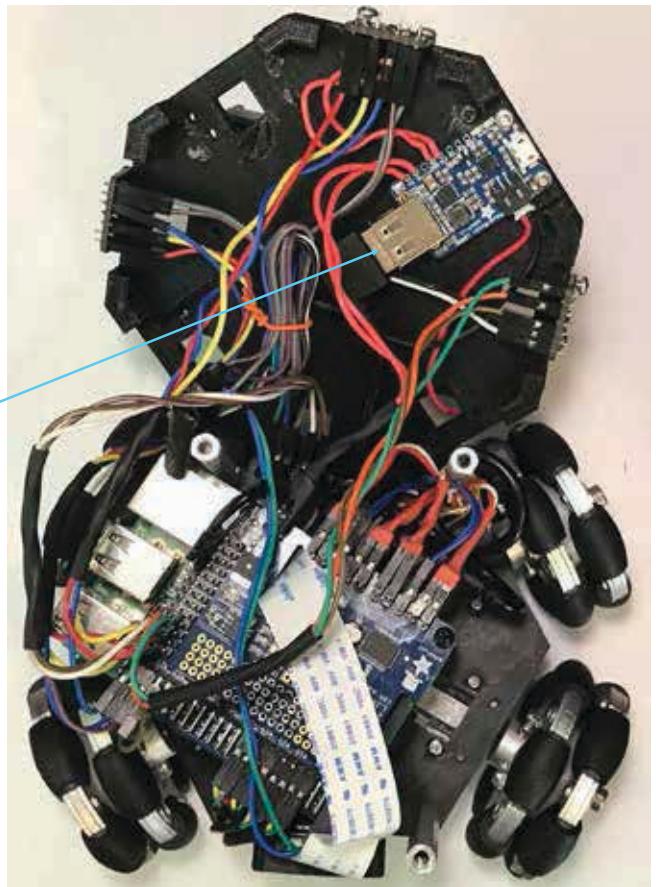


## FINAL ASSEMBLY



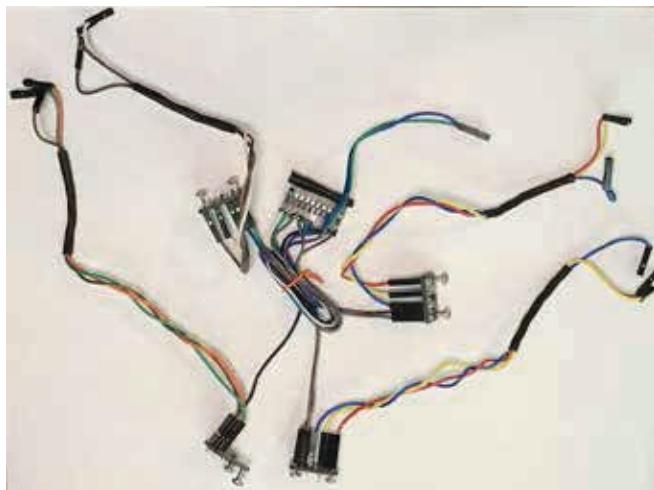
### PARTS

- Chassis Assembly	x	1
- Sensor Holder Assembly	x	1
- 1/2in x 3/32in hex	x	3
- 6in Micro USB to USB Cord	x	1



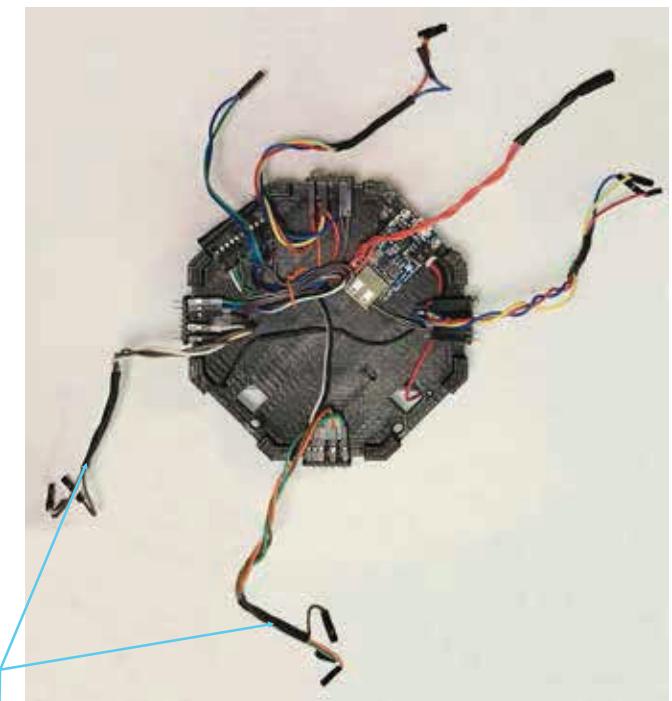
**DO NOT CHARGE THE BATTERIES WITHOUT  
ENSURING THEY ARE ALL AT THE SAME VOLTAGE  
AND CAPACITY! THIS CAN RESULT IN FIRE!!  
FOLLOW ALL PRECAUTIONARY STEPS WHEN  
USING LITHIUM ION BATTERIES**

# SENSORS



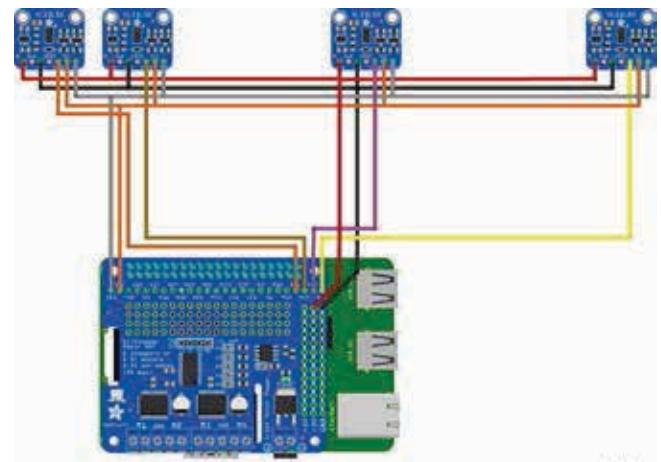
## PARTS

- Adafruit VL52L0X Sensor	x	4
- VL53L0X Header	x	4
- Female/Male 7in Wire	x	22
- 20 Gauge Wire	x	1ft
- 1/2in x 7/64in screw	x	2



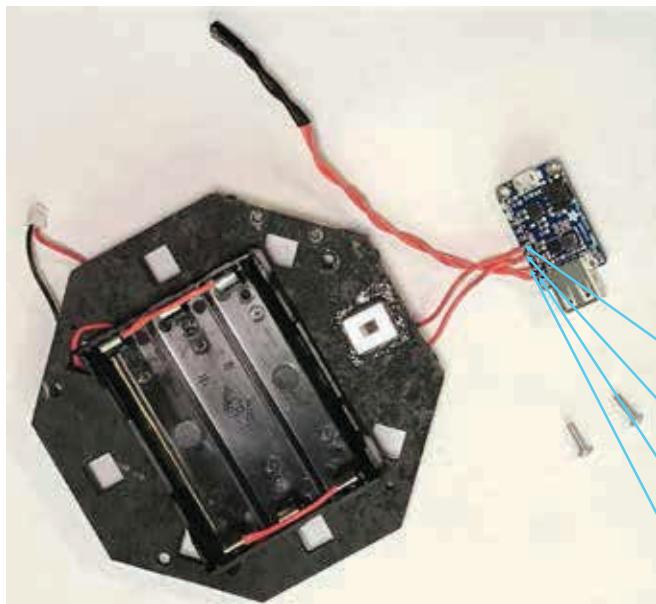
## ASSEMBLY

- Solder included Header on to VL53L0X with the Header facing the back side of the sensor (Header not shown here, male ends were soldered directly to Sensor(mistake))
- Connect 1 female end of each wire to the following pins on each sensor: VIN, GND, SHDN, SCL, SDA  
(Labeling the wires will help identify which are which to help for faster connecting)
- Strip the male ends off of the SDA and SCL wires from each VL53L0X . Do this for two additional unused wires.
- Solder the SDA loose ends and the end of one of the two remaining loose wires together. Cover with shrink tubing
- Solder the SCL loose ends and the end of the remaining loose wire together. Cover with shrink tubing  
(The last two steps are not shown in this picture. I used a 10 piece header, soldered groups of five pins together twice. Then I connected the four SDA females and one extra(to go to the pi. And repeated for the SCL wires.)
- Use shrink tubing to organize the remaining wires
- Screw each sensor on to the sensor holder  
(Be careful that the screws do not touch any



fritzing

## POWERBOOST

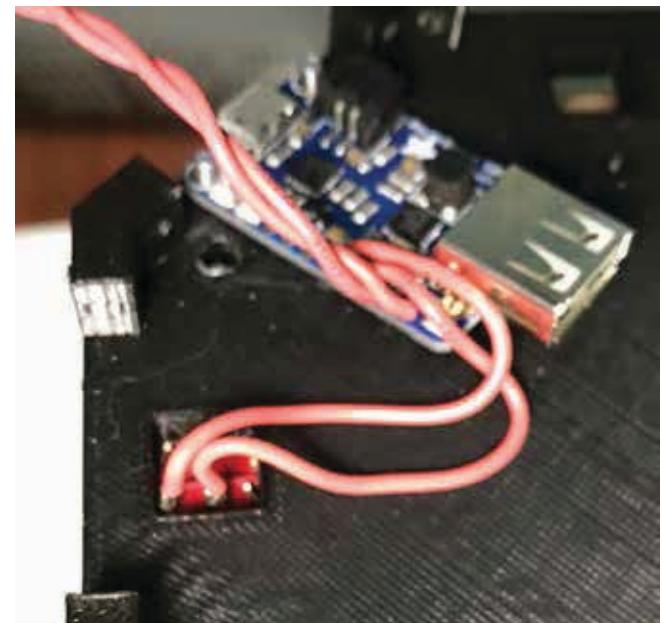
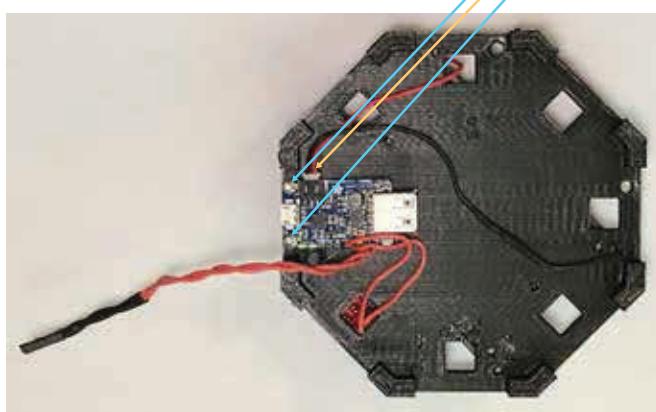
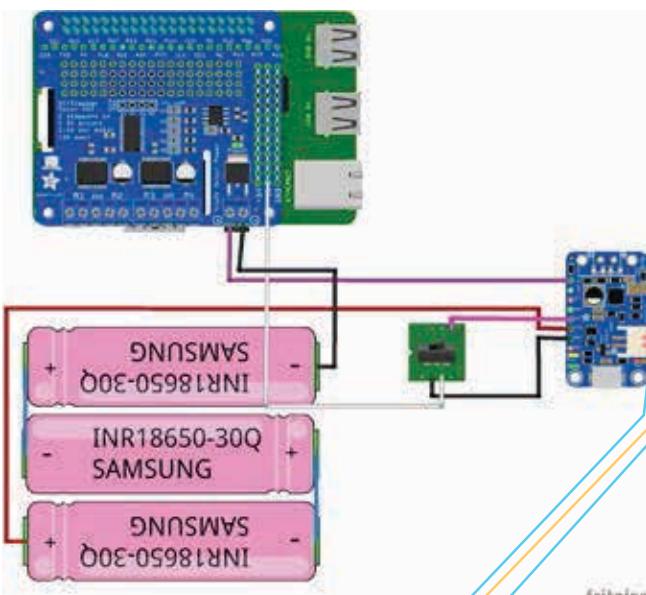


### PARTS

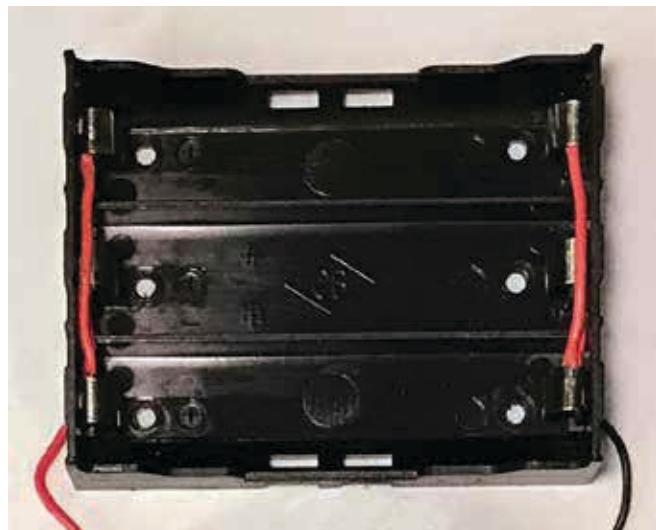
- Sensor Holder Assembly	x	1
- PowerBoost 1000	x	1
- 20 Gauge Wire	x	1ft
- 1/2in x 7/64in screw	x	2
- Female Dupont Connectors	x	2
- Shrink Tubing	x	2in

### ASSEMBLY

- Solder one wire from the Switch to the En(Enable) pin on the Powerboost
- Solder the other wire from the Switch to the GND(Ground) pin on the PowerBoost
- Solder one 6in length of Wire to the 5V pin on the Powerboost.
- Solder another 6in length of Wire to the G(Ground) pin on the PowerBoost
- Crimp dupont connectors on the ends of the two wires and secure them together with shrink tubing
- Screw in the two screws through the Sensor Holder and into the back of the PowerBoost
- Plug in PowerBoost Connector

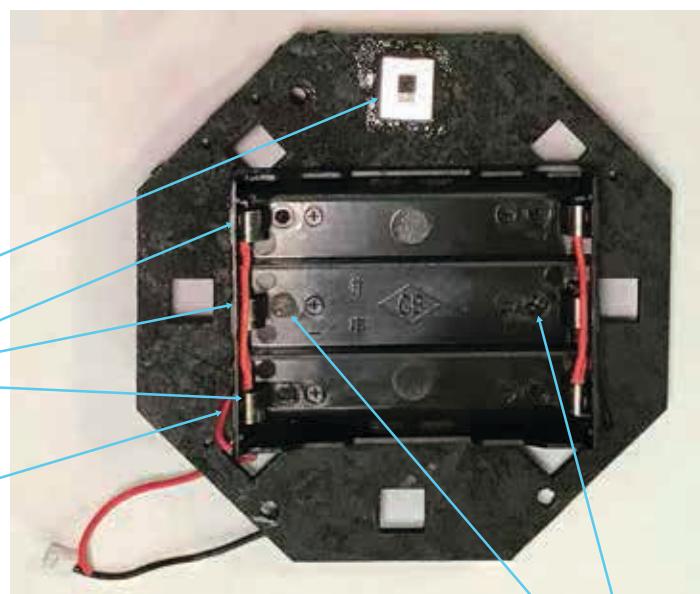


## BATTERIES AND SENSOR HOLDER



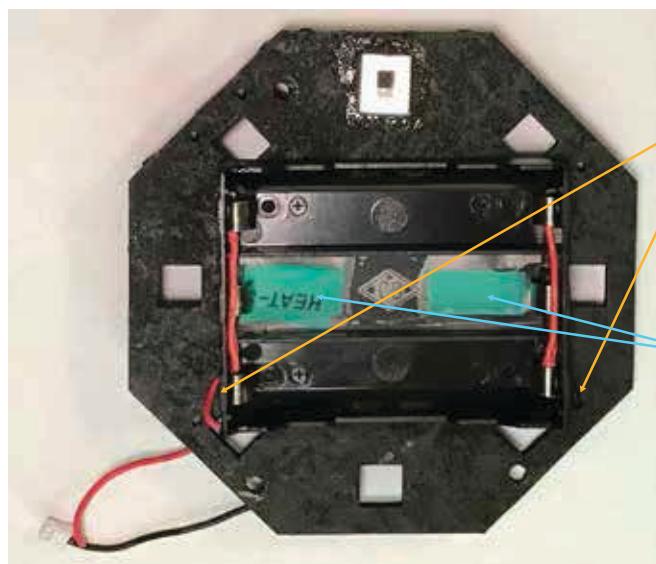
### PARTS

- Sensor Holder	x	1
- Battery Holder	x	1
- SPST Switch	x	1
- 1/8in Flat head screws	x	2
- Female Dupont Connectors	x	2
- 22 Gauge Wire (Red)	x	1 1/2ft
- 22 Gauge Wire( Black)	x	1 1/2ft
- Shrink Tubing	x	4in
- PowerBoost Connector	x	1



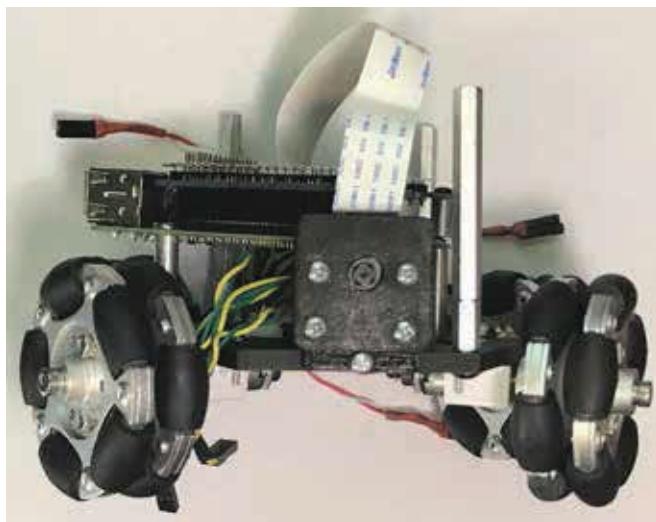
### ASSEMBLY

- Solder two 3in wires to the SPST
- Run wires from Switch through the top of Sensor Holder and attach Switch to Sensor Holder(Glued here)
- Solder wire connecting positive battery terminals together. Do the same for negative terminals
- Solder 3in of wire to positive terminal of Battery Holder. Repeat for negative terminal



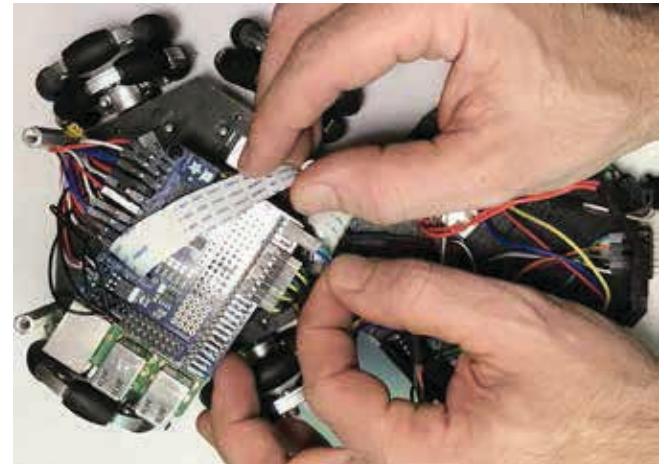
- Run the two wires from the Battery holder through the top of the Sensor holder
- Screw in battery Holder to top of Sensor Holder
- Solder red wire from PowerBoost Connector to positive terminal wire and black wire from PowerBoost Connector to negative battery terminal
- Protect batteries by covering Screws in Battery Holder with shrink tubing. Glue or tape down.

# WIRING



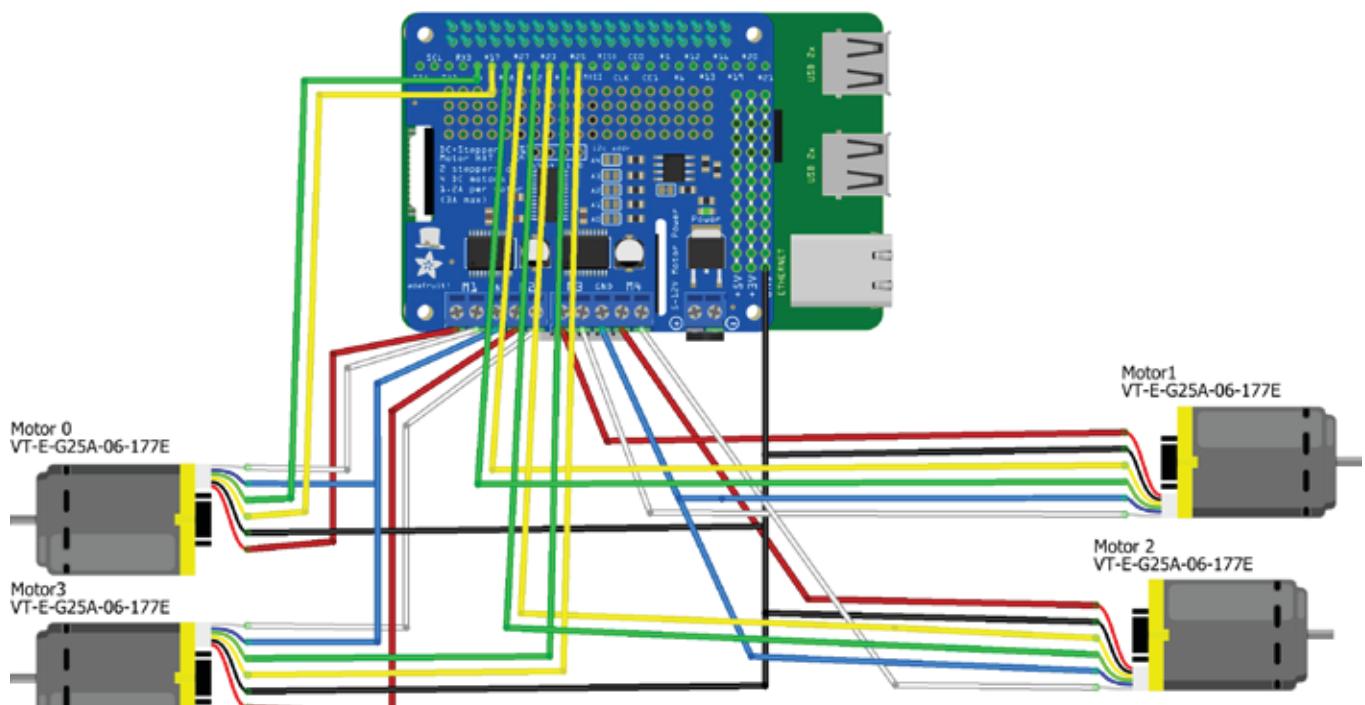
## PARTS

### - Chassis Assembly

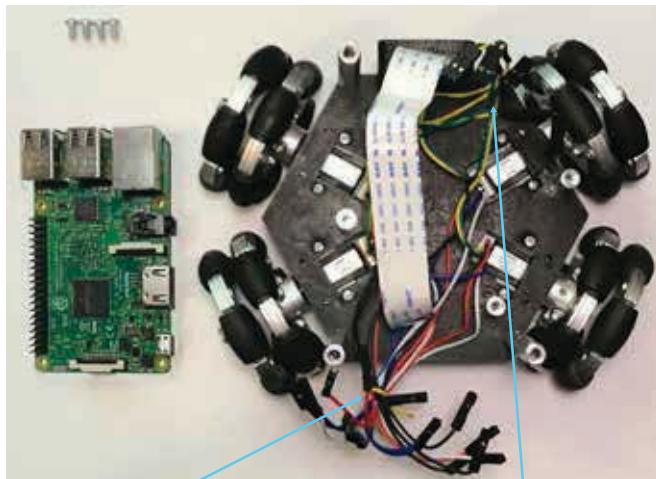


## ASSEMBLY

- Connect the wires from the Motor/Encoder Wire Harnesses to the following pins.

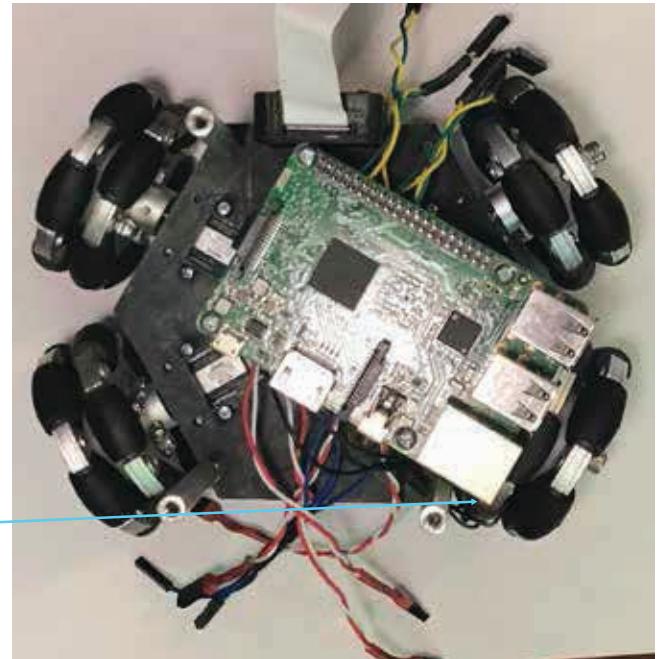


## Raspberry Pi and MotorHat



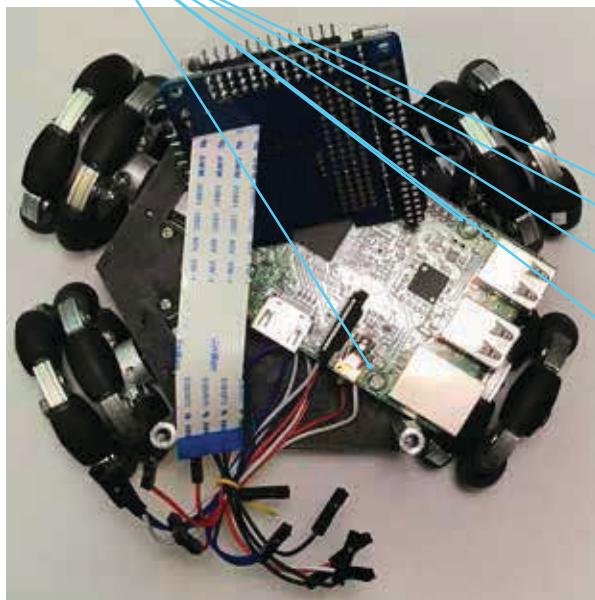
### PARTS

- Chassis Assembly	x	1
- Raspberry Pi 3	x	1
- 1/4in x 7/64in	x	4

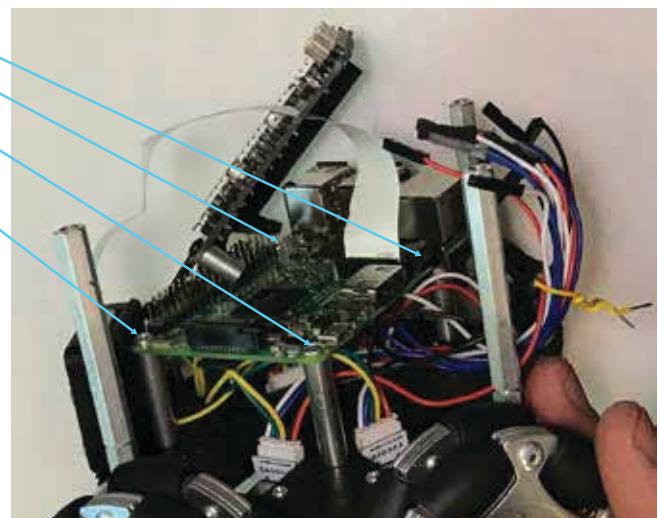


### ASSEMBLY

- Ensure the red white and blue wires are oriented towards the back of the robotito and the green and yellow are oriented towards the front
- Orient the Pi on the 4 1in spacers with the USB ports facing the back right wheel
- Fasten the Pi to the spacers with the 4 1/4in screws

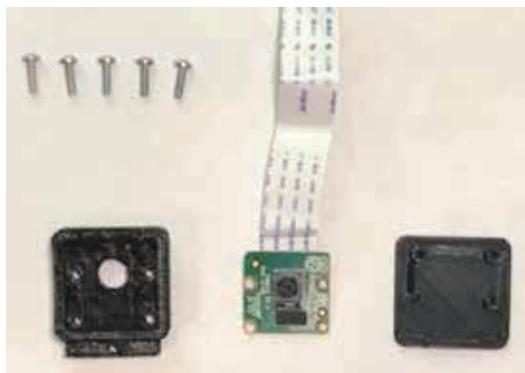


- Orient the Adafruit Motorhat so that its female header pins will align with the Pi's male header pins.



- Place camera ribbon through the Adafruit Motorhat and into the Pi's Camera port. Secure cable in port fastener.

## CAMERA AND MOTOR WIRES

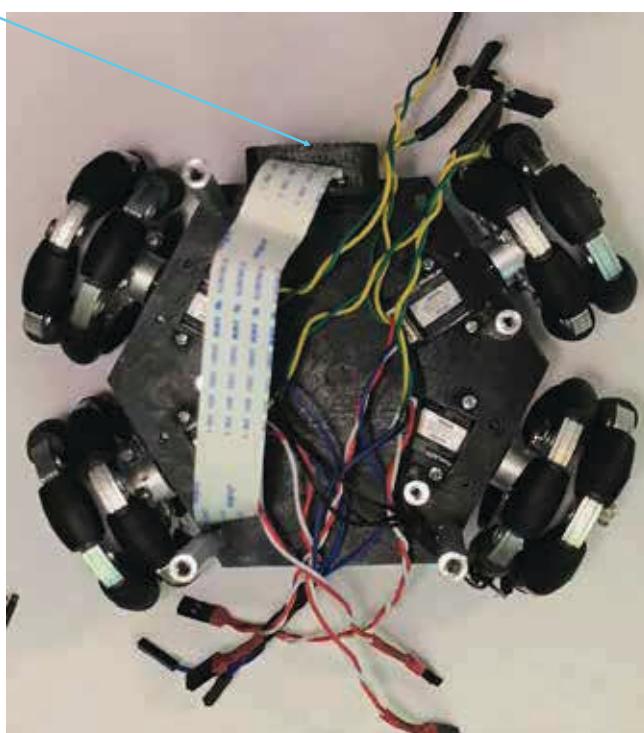


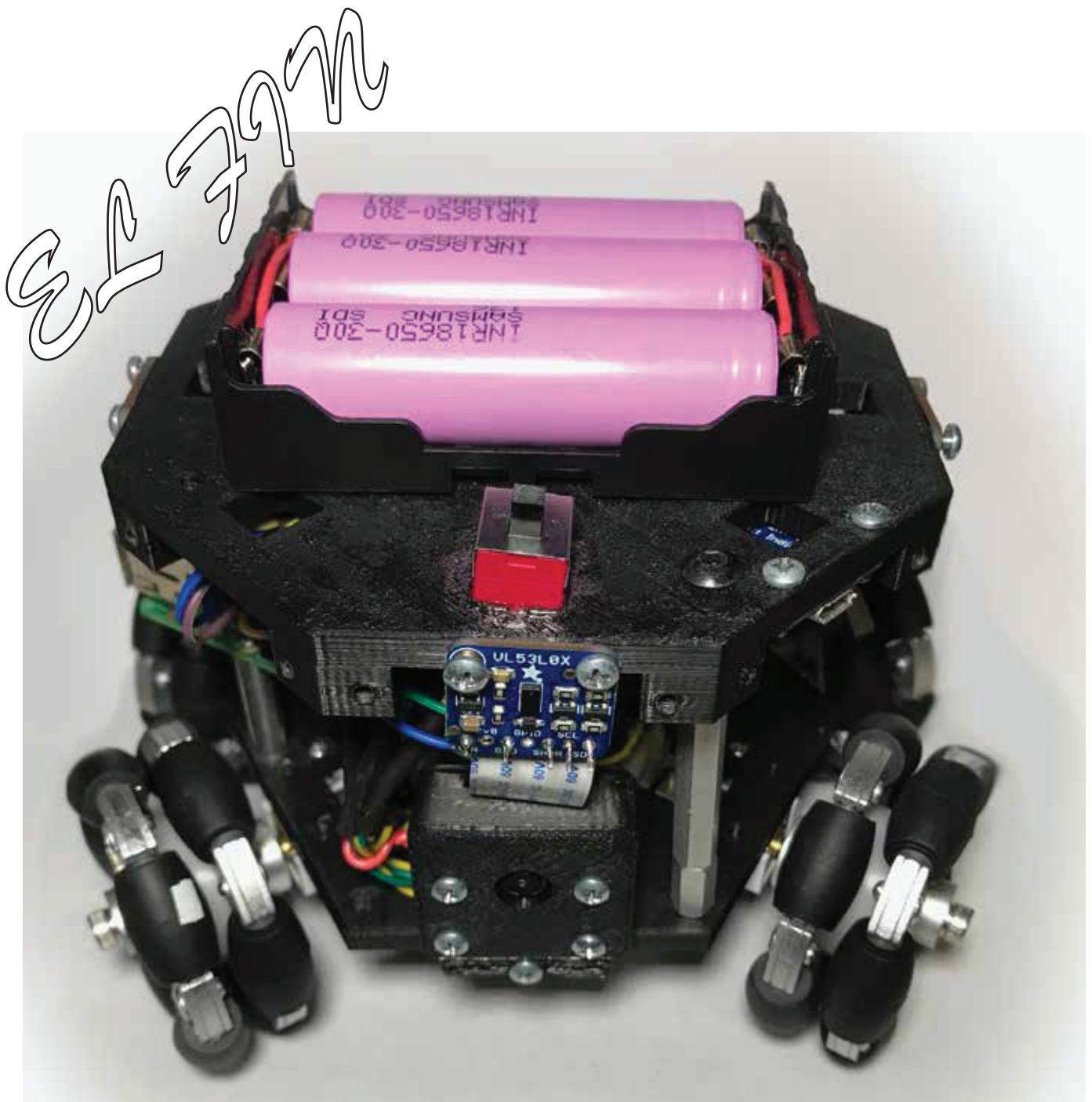
### PARTS

- Chassis Assembly	x	1
- Pi Camera V2	x	1
- Camera Front	x	1
- Camera Back	x	1
- 1/4in x 7/64in	x	5

### ASSEMBLY

- Orient the camera inside the Camera Front facing outward through the hole
- Screw 1/4 Screws into Camera Front until they are flush with Camera PCB
- Place back on Camera Assembly and tighten the four Case Screws
- Fasten Camera Enclosure Assembly on to chassis with remaining screw
- Plug Wire Harnesses into Encoders
- Organize wires on Encoder Wire Harnesses and shrink tube them together. Label wires to keep track of which is which, and which motor they connect to
- Crimp Female Dupont Connectors to the Motor/Encoder Wire Harnesses





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